TECHNICAL NOTES

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A 5-Year Progress Report in a Growing Stock Density Experiment in 60-Year-Old Red Pine

The relationship of basal area and cubic-foot-volume growth to stand density is being studied in several long-term experiments in Minnesota. With each succeeding measurement, the need for information at still wider ranges of stand densities becomes apparent. Prior to 1956 the widest range of basal area densities established on these experiments was 60 to 140 square feet per acre.

In 1956 a thinning experiment was begun in a red pine stand where the lowest density was 30 square feet of basal area per acre and the highest density of thinned plots was 150 square feet. Unthinned control plots were also established. This is a brief report on the first measurement period. The results show substantial agreement with three older red pine experiments[1/] for the common range of densities and add information at higher and lower densities.

The study, installed cooperatively by the Minnesota and Ontario Paper Company and the Lake States Forest Experiment Station, is located about 25 miles southwest of International Falls, near the northern border of Minnesota. The red pine averaged 58 years in 1956. Site index is about 55 at age 50, which is slightly better than medium for Minnesota. Before thinning, the stand contained some white pine, aspen, and white spruce. No thinning or other cultural treatment had been done in the stand prior to installation of the experiment.

The treatments consisted of thinning the stand to densities of 30, 60, 90, 120, and 150 square feet of basal area per acre. Unthinned treatments were also established with average basal areas of 175 square feet per acre. Measurements were made on 1/7-acre plots; each plot and its surrounding buffer zone together are 1 acre or more in size. Two replications were installed at age 58, the third at age 59. At age 63 the compartments were remeasured, and all three replications were thinned back to the assigned basal areas. The growth responses reported here are based on observations taken after 5 years on two replications and 4 years on the third.

The curves in figure 1 show gross and net periodic annual increment for basal area and for cubic-foot volume. The gross growth curves extend to 175 square feet of basal area, the highest density of the unthinned plots. Net growth curves extend to 150 square feet of basal area, the range of data to which they were fitted.

Tabulated below are the equations for predicting periodic gross and net annual increment in basal area and in cubic-foot volume from stand density in basal area. R^2 measures the proportion of the total variability around the grand mean that is accounted for by the prediction equation (all growth is per acre per year).

1/ Buckman, Robert E. Three growing stock density experiments in Minnesota red pine--a progress report. U. S. Forest Serv., Lake States Forest Experiment Station. Sta. Paper 99, 10 pp., illus. 1962.

	Increment equations				R^2	BA range of application
Gross basal area	= 0.19 +	.0341BA -	$.0000964BA^2$		0.80	30 - 175
Net basal area	= .18 +	.0351BA -	$.0001256BA^2$		.53	30 - 150
Gross cubic feet	= 2.4 +	1.311BA -	$.00306BA^2$		.91	30 - 175
Net cubic feet	= 10.4 +	1.257BA -	$.00392BA^2$		.66	70[1]/ - 150

1/ Use gross figures for BA from 30 to 70.

The gross basal area growth curve rises to a maximum of 3.2 square feet per acre per year at a basal area of 175 feet. The gross cubic-foot growth curve continues to rise across the entire range of densities for which information is available.

Net basal area growth attains a maximum of 2.6 square feet per acre per year at 140 square feet of basal area, whereas net cubic-foot volume growth continues to rise beyond 150 square feet, the highest density from which the curve was derived. Stand densities 20 to 30 feet lower than the maxima given above make very little practical difference in growth rates. In terms of net cordwood growth (on the basis of 100 cubic feet per cord), the 30-, 60-, 90-, 120-, and 150-square-foot densities produced, respectively, .45, .72, .92, 1.05, and 1.11 cords per acre per year.

The minor quantities of aspen and white pine remaining in the high density and unthinned compartments suffered a disproportionately heavy mortality--the white pine because of blister rust (Cronartium ribicola), the aspen because of advancing age. These species were left as "filler growing stock" and were to be removed as soon as sufficient red pine basal area was present for the assigned density.

For the three unthinned plots the average net increment in basal area was 1.4 square feet per acre per year; net cubic-foot-volume increment was 92 cubic feet per acre per year. This is much lower than the growth of lightly thinned plots (those with a high residual density).

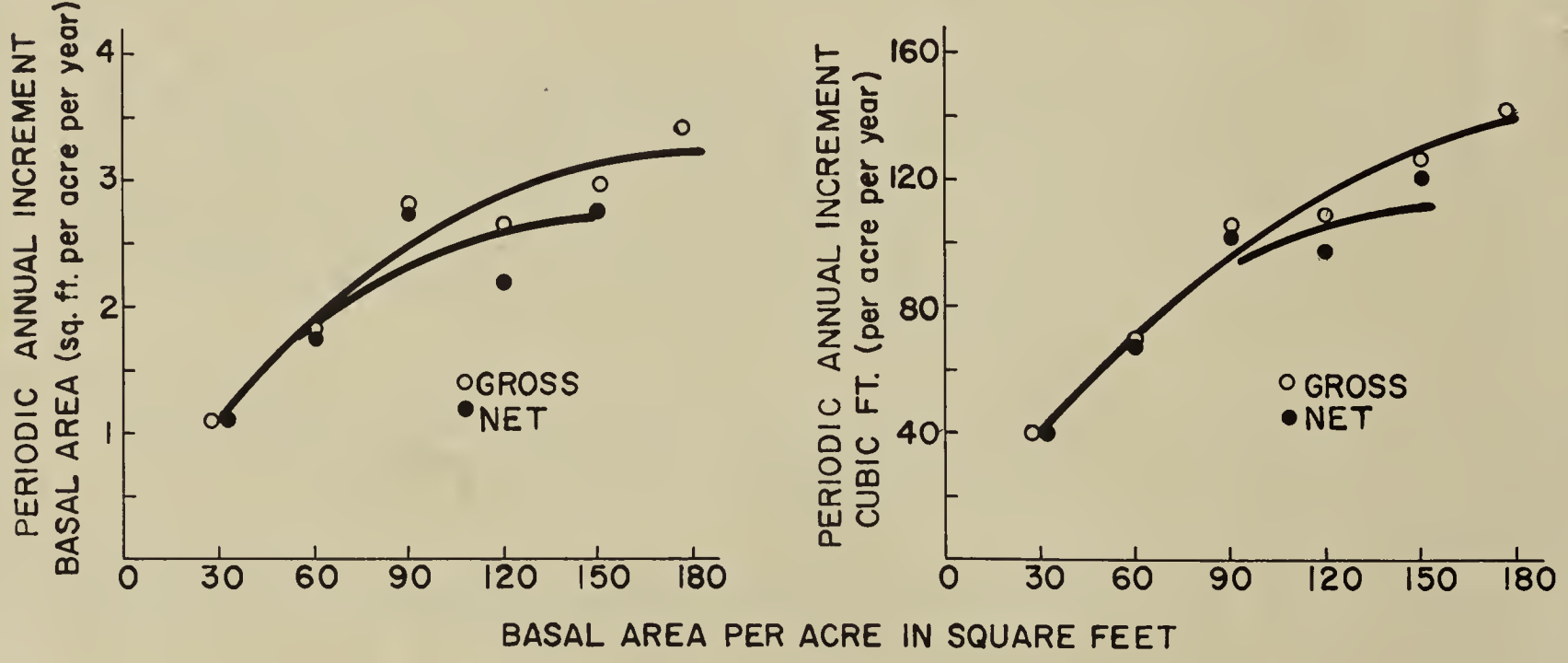

Figure 1.--Gross and net periodic annual increment curves for basal area (left) and cubic-foot volume (right) in relation to stand density in basal area. Each dot represents the average of three replications. Gross growth was calculated for all plots, net growth for thinned plots only.

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